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THE RELATIONSHIP BETWEEN ELECTRICAL POTENTIALS AND CHEMICAL REACTIVITY[1]

By Professor LOUIS KAHLENBERG

UNIVERSITY OF WISCONSIN

WE are to-day celebrating the seventy-eighth anniversary of the birth of Edgar Fahs Smith, who was so personally beloved by us all. It is consequently fitting that we pause to dwell upon those phases of our science in which he was specially interested. Though Dr. Smith busied himself with a large number of chemical problems covering a wide field, yet it will commonly be conceded that no work was more dear to him than his electrochemical researches and his studies in the history of the development of chemistry. It would, therefore, seem specially appropriate to consider a topic in these domains, and so I have chosen to invite your attention to the relationship between electrical potentials and chemical reactivity.

[1] Edgar Fahs Smith memorial address delivered at the Chemical Laboratory of the University of Pennsylvania.

The most striking thing about chemical phenomena is the fact that they depend mainly upon the specific nature of the substances that are brought together. Unless the right substances are chosen, no chemical change takes place, no matter what are the conditions of temperature, pressure, concentration or excitations caused by electricity, light or other agencies. The explanation of chemical change has always been the assumption of a specific attraction, that is, an affinity of the substances for one another, an affinity which depends entirely upon the specific nature of the substance studied. Naturally, the desire to measure the intensity of this affinity has occupied chemists quite early in the history of the development of our science. Perhaps the first systematic attempt in this direction was made in the eighteenth century by Torbern Berg-

man, when he arranged the metals in a series in the order in which they will replace one another in solutions of their salts in water. His work constitutes an important contribution to this day.

As soon as the discovery was made that many substances may readily be decomposed by electrolysis, Sir Humphry Davy, with an impetuosity that was characteristic of him, jumped to the conclusion that chemical affinity is electrical in character and that the constituents of a chemical compound are held together by electrical attraction. He consequently proposed to use electrical means to measure chemical affinity, and developed this idea especially in his Bakerian lecture in 1826.[2] Unfortunately, knowledge of electrical phenomena had not yet progressed far enough to distinguish between what we now call voltage and amperage, and, of course, electrical measuring instruments were in their infancy. As long as attempts were made to use a galvanometer to evaluate chemical affinity, the results were doomed to failure. Davy was a brilliant experimentalist and not a propagandist, and so while he was the first to put forth an electrochemical theory, that fact is usually overlooked. It was through the electrochemical explanations of Berzelius that the dualistic view of chemical combination became thoroughly rooted; for Berzelius was not only a careful and indefatigable experimenter, but he was also a prolific writer. His Lehrbuch and his Jahresbericht were regarded as authority for nearly half a century. Nevertheless, during all this time quantitative relations between chemical affinity and electrical phenomena were not found, for clarity concerning the latter did not yet exist. This is especially emphasized by the fact that Berzelius himself was completely ignorant of the difference between electric current and electromotive force; and so, when Faraday published his laws of electrolysis and cited his experimental facts supporting these laws, Berzelius in reviewing this fundamental work in his Jahresbericht adopted an extremely critical attitude toward it. The views expressed by Berzelius clearly indicated that he did not know the difference between electrical energy, voltage and amperage. This is not at all surprising, for these distinctions were also unknown to Faraday at the time; in fact, they were developed much later.

Faraday worked experimentally. He kept his mind singularly free from preconceived notions—theories which by their implications constitute a serious hindrance to the discovery of new, fundamental facts. His efforts to unravel the nature of electrical conductance, especially when it is accompanied by chemical decomposition, namely, electrolysis, are a masterpiece, albeit he did not succeed in solving the mystery, and we still find ourselves at the present day without adequate explanations to account for the many facts that we possess.

When in the forties and fifties of the nineteenth century, through the efforts of Julius Robert Mayer, Kelvin, Helmholtz, Joule and Clausius, the mechanical theory of heat was developed and our notions of the transformation of energy became clarified, and Kelvin actually computed the E.M.F. of the Daniel cell from a knowledge of Faraday's law and the heat of the chemical reaction, $Zn + CuSO_4$ aq. $= ZnSO_4$ aq. $+ Cu$, and found that the result agreed with the experimentally determined voltage of the cell, a very important advance had been made. The attempt to apply the same methods to the Latimer Clark cell containing mercury and mercurous sulphate, instead of copper and copper sulphate, as in the Daniel cell, at first failed and cast a gloom on the situation; but Helmholtz pointed out that the discrepancy between computed and found value was due to the fact that the Clark cell has a high temperature coefficient, as compared with the Daniel cell, whose temperature coefficient is so low as to be practically negligible. He developed his famous equation in which the temperature coefficient is duly considered, and this cleared away the existing difficulties.

As a consequence of this recognition of the fundamental facts of the transformation of energy and of the development of the means of measuring energy and its intensity and capacity factors, ideas were clarified and the road to substantial advancement was opened.

The period of 1850 to about 1880 was notable for the development of thermal chemistry. The dominant idea during these three decades was that chemical affinity could be evaluated by measuring the heat evolved or absorbed during the reaction in question. Both Julius Thomsen and Marcellin Berthelot practically devoted their lives to the attempt to measure chemical affinity by thermal means. In their enthusiasm, industry and zeal, they invented and perfected many calorimeters to accomplish their purpose. They determined in the laboratory and finally compiled an enormous amount of thermochemical data which form a valuable stock of knowledge. They also formulated generalizations in the shape of laws governing these thermochemical phenomena. Nevertheless, the main objective, namely, the evaluation of chemical affinity, was not achieved, for the reason that the thermal accompaniment of a chemical change represents the algebraic sum of a number of processes, physical and chemical, that take place during the reaction, and it is commonly not possible to evaluate each of these separately as to its effect on the final heat change that is actually measured. The realization of this

[2] *Philos. Trans.*, p. iii, 1826, and *Phil. Mag.*, 1, 31, 1827.

me after most of the thermochemical experiments d been done. Perhaps the most promising thermal easurements for comparing chemical affinity are the udy of the avidity of acids by Julius Thomsen; but en here the conclusions reached are subject to ques- on in the light of more recent experimentation.

The resurrection of the law of mass action by Guld- erg and Waage in the sixties of the last century ave an impetus to the study of the speed of chemical hange and chemical equilibria. This enabled the gical arrangement of acids and bases, according to eir relative affinities; and to the present, the law of ass action, and its consequences, offers the best eans we have of comparing chemical affinities, so at investigations of the rate of chemical change nd of chemical equilibria are justly popular.

With the advent of Arrhenius' hypothesis in the ighties, attention was again centered on electrochemi- al matters, and the idea gradually grew that electro- tic conductance and chemical reactivity go hand in and, so that, for example, the strength of an acid r a base could be compared by the electric con- uctance of its aqueous solutions. This theory natu- ally spurred experimental inquiry in the study of he electric conductance of aqueous solutions. It was losely followed by Nernst's theory of the electric otential developed by a metal when it dips into a olution of one of its salts. This hypothesis, which one might be disposed to term a natural consequence of Arrhenius' theory and van't Hoff's view of solu- tions, led to many experimental determinations of so-called single potentials of the various metals in solutions of their own salts, from which data the theoretically conceived "solution tensions" of the several metals were then computed. These solution tensions were generally expressed in atmospheres, and they were either fabulously large or ridiculously small, varying, for example, from about 9.9×10^{18} atmospheres for zinc to 2.3×10^{-17} atmospheres for silver, the logarithmic nature of the Nernst function resulting in these fantastic figures, which are still paraded in good faith in many of our text-books.

Quite aside from Nernst's rather mechanical theory, the idea that chemical energy can be transformed into electrical energy and that the intensity factor of elec- trical energy, namely, the electric potential, is propor- tional to the intensity factor of chemical energy, namely, chemical affinity, appears thoroughly sound; and since in all cases of electrolytic decomposition Faraday's law holds, it should be quite possible to compare chemical affinity by the method of Kelvin and Helmholtz from the voltages developed.

Nernst's theory inspired much experimental work, though this was actually directed toward determining electrode potentials of the metals in dilute aqueous solutions of their salts, and not at all toward ascer- taining the real cause of such potentials, for the theory itself already stated that as known.

The arrangement of the metals in a series, accord- ing to their electrode potentials, is commonly known as the electrochemical series of the metals, and such a series is in general parallel to that obtained when the metals are arranged according to their chemical replacing power. Nevertheless, the two are by no means always identical.

For a number of years I have studied the electro- chemical series of the metals in the laboratory, and it has been found that the series is a function of the solvent and of the substance or substances dissolved in the latter as well as of the specific nature of the metal of which the electrode consists. These re- searches have appeared in the *Journal of Physical Chemistry* and the *Transactions* of the American Electrochemical Society. In these papers it has been demonstrated that the electrochemical series of the metals is not a fixed thing.

It is particularly interesting that the brittle metals, like arsenic, antimony and bismuth, and even silicon, which are frequently called half metals or metalloids, lie higher in the chemical series than do many of the real ductile and malleable metals like copper, silver, gold and platinum. As a striking illustration, the slightly basic power of arsenic will be commonly admitted, for it unusually functions as a part of the acid radical in its salts; and yet, arsenic lies relatively high in the electrochemical series. It readily replaces copper, mercury, silver, gold and platinum from aqueous solutions of their salts. The electrode poten- tials of arsenic in these cases run parallel with the replacing power. One is specially surprised that silicon should also be able to replace copper and that its potential lies above that of the latter. Silicon is usually regarded as less metallic than arsenic.

For many years the Royal Society of London had a committee on the seat of E.M.F. of the voltaic cell. At this time, Kelvin performed his interesting series of experiments in which he measured the potentials which the various metals developed against a gold plate used as a standard. In the course of those investigations, it was shown that the potential of a metal is determined primarily by its specific nature, but that it is nevertheless very materially influenced by the mechanical treatment to which its surface had been subjected. So, for instance, the potential of zinc taken from a cast piece may be raised successively by scratch-brushing it, polishing it and finally burnish- ing it on a steel burnisher. On the other hand, the electrode potential of zinc in aqueous solutions is not much altered by such treatment, which might well call

into question whether the contact potential and the electrode potential are, after all, quite comparable.

In Chapter 12 of his book, "Electrochemie, Ihre Geschichte und Lehre" (1896), Wilhelm Ostwald relates and critically reviews the controversy between the contactists (*i.e.*, the followers of Volta who insist that E.M.F. is developed by mere contact of two different bodies) and those who contend that E.M.F. is due to chemical forces. Ostwald unquestionably exerted himself to present both sides of the problem impartially; nevertheless, being at the time personally enamored of the Arrhenius and Nernst theories, he was quite unable to divest himself of the effects of these doctrines.

It has now been definitely established experimentally that, whenever two different bodies touch each other, an electrical disturbance takes place and both bodies become oppositely charged. This is true in all cases, no matter whether the bodies be solids, liquids or gases. The charges developed depend as to sign and intensity on the specific nature of the bodies that are brought together. Moreover, two bodies that are chemically identical and more or less different physically will also develop differences of electrical potential when brought into contact. Those who contend that E.M.F. is caused by chemical action insist that only thus can one understand where the electric energy comes from, and they have in their favor the fact that demonstrable chemical action does accompany electrical potentials in many cases. On the other hand, it can not be questioned that potentials are also developed when there is no chemical action. Ostwald (*loc. cit.*) points out that Pfaff, one of the great exponents of the contact view of Volta, finally sought to show that the contact view and the chemical theory do not necessarily mutually exclude each other. His explanation was highly regarded by his contemporaries, particularly by Faraday and Schönbein. What the notion amounts to is that gross matter is enveloped by an electric atmosphere, which is clearly defined yet different around different bodies, and which is disturbed whenever the latter touch each other, thus bringing about differences of potential. With our present electronic theory of matter, the views of the contactists and chemical contenders are, of course, far more readily harmonized; for it can easily be understood that electrical strains can be set up between two bodies that are in contact, before they actually react chemically upon each other so that this can be experimentally detected.

Perhaps no phase of the study of electromotive forces is of greater interest than that of the so-called gas electrodes. I have in mind especially the hydrogen electrode. Gas electrodes[3] have really been known ever since the electrolysis of water was discovered. A gas electrode consists of a metal or some other first-class conductor in which the gas in question is absorbed, this electrode dipping into an electrolyte. Through the Nernst theory the potential of such electrodes became a special object of study. This is particularly true of the hydrogen electrode, by means of which the so-called hydrogen-ion concentration of a solution, that is, its degree of acidity or alkalinity, may be measured.

The term gas electrode is really a misnomer, for the gas electrode is in fact a gas-metal electrode or a gas-carbon electrode, the first-class conductor in which the gas is adsorbed having a perfectly distinct and definite effect upon the potential that is developed. At the same time, it is not to be denied that the gas also powerfully affects this potential. The hydrogen electrode is usually formed by absorbing that gas in an electrode of platinized platinum, and such electrodes, though they are platinum-hydrogen electrodes and not merely hydrogen electrodes, are fairly reproducible experimentally. Moreover, they serve well to indicate different degrees of acidity, as is well known. This, according to the Nernst theory, is to be ascribed to the fact that equilibrium between the hydrogen of the electrode and the "hydrogen ion" in the electrolyte tries to establish itself, and hence the hydrogen electrode "reacts" on "hydrogen ions" present. However, it has recently been demonstrated[4] that quite a number of other electrodes which are not at all laden with hydrogen indicate the acidity or alkalinity of solutions quite as well and even better than the so-called hydrogen electrode. Among these electrodes plain tungsten and molybdenum occupy a foremost place. This observation has manifestly nothing to do with Nernst's theory, the inadequacy of which I have pointed out thirty-three years ago. In fact, electric titrations of acids and bases by means of a tungsten electrode are more readily effected and more convenient than by means of a so-called hydrogen electrode. Just why metals like molybdenum, tungsten and antimony should be sensitive electrical indicators toward acids and bases is not yet fully understood. Other metals, like copper and silver, are not at all sensitive in this respect, and so the tungsten-copper or the tungsten-silver couple may be used to ascertain the degree of acidity of solutions. All that is necessary is to dip such a couple into the solution in question and measure the E.M.F. developed, which is a known function of the acidity. The polarity of such couples actually reverses after passing the point of neutrality, showing that the combination is unusually sensitive. Moreover, tungsten develops and maintains

[3] See *Trans. Amer. Electrochem. Soc.*, 58, 107, 1930.

[4] *Trans. Amer. Electrochem. Soc.*, 56, 201, 1929, and 57, 361, 1930.

its own potential so strongly that it is but slightly affected by the presence of gases. That is to say, a tungsten electrode, loaded with hydrogen or any other gas, develops about the same potential in all cases. *This is a specific property of tungsten.* Molybdenum acts similarly; that is to say, both of these metals are very sensitive to changes in the degree of acidity or alkalinity of a solution. The electrical sensitivity of the various metals toward acidity and alkalinity has been carefully studied in my laboratory, and the order of the metals in this respect is about as follows, the most sensitive being given first: Pt (platinized), W, Sb, Mo, Pt (plain), As, Si, Bi, C (Acheson graphite), Cr, Au, Cu, Ag, Pb, Fe, C (natural graphite), Cd, Ni, Co. It is evident from this that the order has nothing to do with the electrochemical series or with the periodic system. It stands alone, and one can not at present connect this property with any other known property of the metals concerned. Thus the series is a singular one, just as is the case with the thermo-electric series of the metals. Further experimental inquiry will probably yield an explanation of this curious property of the metals.

When arranged as to their sensitivity toward gases, as determined by the single potentials which they develop, the order of the metals is about as follows, the metals whose potential is most affected by gases being given first: Pt, Ag, Cr, Cu, Fe, Mg, Sn, As, Au, C, Cd, Pb, Hg, Mo, W, Zn.

Here again we see no relationship to the periodic system nor to any other known property of the metals concerned.

The systematic investigation of gas electrodes, so-called, in my laboratory has shown that metals whose single potential is altered by any one gas, like hydrogen, for example, are also marked affected by other gases, like oxygen, nitrogen, helium, argon, neon, carbon monoxide, methane, ethylene, acetylene, etc.

When I first reported my experimental work on nitrogen electrodes at a meeting of chemists at Chicago, I was told that nitrogen electrodes can not exist, since there are no nitrogen ions known. I naturally remarked that that did not bother me at all. One can see from this incident, however, the unfortunate influence of the Nernst theory in thwarting experimental inquiry by virtue of its implications. Nitrogen electrodes are quite as active as hydrogen or oxygen electrodes. In fact the same is true of electrodes of compound gases and even of electrodes of the noble gases, argon, helium and neon. The following Table I gives the potentials of the elemental gases when these are adsorbed in platinized platinum and immersed in nKCl, nKOH, and nHCl solutions, respectively. The figures represent millivolts and are then in each case the total E.M.F. of the electrode in question against the usual nKCl calomel electrode.

TABLE I

PLATINUM, PLATINIZED ELECTRODE POTENTIALS[5]

	nKCl	nKOH	nHCl
Nitrogen	−330	106	517
	−332	101	512
Hydrogen	398	817	301
	399	815	298
Argon	359	1,050	305
	360	1,039	303
Helium	295	1,012	102
	296	1,010	98
Oxygen	357	28	−6
	360	23	2
H_2 and O_2	755	789	307
Chain	759	789	296
H_2 and N_2	728	711	−216
Chain	731	714	−214
N_2 and O_2	27	78	523
Chain	28	78	510
H_2 and He	103	−195	199
Chain	103	−195	200
He and O_2	652	984	108
Chain	656	987	96
N_2 and He	−625	−906	415
Chain	−628	−909	414
H_2 and A	39	−233	−4
Chain	39	−224	−5
A and O_2	716	1,022	311
Chain	720	1,016	301
A and N_2	689	944	−212
Chain	692	933	−208
A and He	64	38	203
Chain	64	29	205

Table II gives similar data in volts obtained with plain platinum electrodes of the compound gases.

TABLE II

PLAIN PLATINUM GAS ELECTRODE POTENTIALS

	O_2	CO	C_2H_2	C_2H_4	C_2H_6	CH_4	H_2
nKOH	0.213	0.245	0.264	0.280	0.318	0.337	0.348
nKCl	−0.004	0.013	0.024	−0.002	0.061	0.038	0.119
nHCl	−0.342	−0.232	−0.210	−0.202	−0.191	−0.184	−0.176

An inspection of Table I clearly shows that nitrogen and the noble gases give fully as high and as individually characteristic potentials as do hydrogen and oxygen. All work was done at room temperature 20° C. Neon has also been found to develop similar characteristic potentials of its own. The results will soon be published.

In the case of the compound gases studied, Table

[5] The two values given in each case were obtained from independent experiments and consequently indicate how closely the electrodes are reproducible.

II, it is evident that the potential developed varies regularly with the composition of the gas from acetylene, which contains least hydrogen, to methane, which contains most.

In all gas electrodes the results are greatly affected by the nature of the first-class conductor in which the gas is absorbed. Table III[6] gives an interesting arrangement of the elemental gases. It represents these in decreasing order of the basicity of the potentials which they produce in three different electrolytes and when absorbed in the various metals listed.

Regarding these experimental data, particularly the potentials developed by helium and argon, which are chemically inert and so far as we know at present do not form chemical compounds at all, one naturally again raises the question, Are the potentials developed by mere contact or are they due to chemical action? It is quite certain that one can not say, at least so far as the noble gases are concerned, that the E.M.F. is due to chemical action, for no chemical change takes place, and we know of no authenticated cases in which these gases have gone into chemical combinations. One might, however, argue that the potentials are, after all, caused by chemical affinity, that is, by special chemical strains, which are insufficient in magnitude to overcome existing cohesions and are consequently unable to produce actual chemical reactions. The data collected in the case of the noble gases might, of course, be construed as indicating that those gases are by no means as inert chemically as is at present supposed, and that special exertions ought once more to be made to form chemical compounds with them and other elements. Such experimentation would doubtless be desirable, especially since recently some biologists have reported that life can not endure in an atmosphere composed of pure oxygen and nitrogen, thus indicating the possibility that the rare gases of our atmosphere might after all play an important rôle, and that it may be chemical in character.

Instead of using the observed potentials of the rare gases as an argument in favor of the contact theory and against the chemical development of potential, I am disposed to use those facts rather as an indication that we are still quite ignorant as to the real fundamental relation between what we term gross matter, on the one hand, and electricity, on the other. To be sure we are now, on the basis of our electronic theory of matter, constructing quasi-astronomical configurations to represent each of the atoms of the known chemical elements; and I have no fault to find with this, for I am still in hopes that this atomic structure speculation may lead us to some new knowledge and not prove to be merely another interesting attempt to account for some of the facts we have observed. It is well to bear in mind that our conception of a chemical element is that of a substance which has thus far defied our efforts to resolve it into something else, and that our atomic theory is founded on the ratios in which the elements combine by weight, that is to say, upon the three stoichiometric laws. Moreover, it is also well to recall here that the molecular conception has for its basis the laws of Gay Lussac of combination of gases by volume and that, for instance, we distinguish between the atom H and the supposed molecule H_2 simply because we want to hold Avogadro's hypothesis, which naturally grows out of the facts of Gay Lussac's law, when it is regarded in the light of the atomic theory. This being the real situation, is it surprising that we are not able to correlate optical, electrical, radiant and kindred phenomena with our atomic conceptions; and that, however valiantly pursued, our so-called atomic structure ideas are not yielding what they at first promised?

This is preeminently a time when careful, entirely new experimentation is necessary—experimentation that is not overawed by the work of the desk warriors, who with long intricate mathematical equations founded upon inadequate factual data overawe the young, ardent experimenter and stifle his efforts by leading him to think that practically everything of a fundamental nature is already ascertained, and that only a few little finishing touches are now required to complete the picture.

To the young investigator I would rather say—and I am sure that in doing so I would voice the spirit in which Edgar Fahs Smith ever worked and taught and inspired his students—Go into the laboratory and by means of careful experimental inquiry and observation seek to unravel the problems of our science, seek to penetrate the mystery of the relation between gross matter and electricity and thus solve the relationship between chemical reactivity and electrical potentials.

[6] This rather elaborate table, giving the results with twenty-nine different metals, each laden with A, H_2, He, O_2 and N_2, respectively, and investigated in KCl, KOH and HCl, is identical with that on p. 143, Vol. lviii, *Trans. Amer. Electrochem. Soc.*, and so is not reproduced here.

OBITUARY

ULYSSES SHERMAN GRANT

DR. ULYSSES SHERMAN GRANT, professor and head of the department of geology and geography at Northwestern University, died at Evanston on September 21. The end came unexpectedly after a brief illness and a major operation, following his return from the

Lake Superior Region, where he had been with a group of graduate students studying Precambrian geology.

Born at Moline, Illinois, Dr. Grant spent his boyhood days near Des Moines, Iowa, where he became an enthusiastic collector of snails and snail shells. In this he already showed himself a close observer and a great lover and student of the out-of-doors. These traits remained with him to the end. He entered the University of Minnesota and was graduated from there at the age of 21. Accepting a fellowship in biology, he continued his studies there the following year. The year after found him at Johns Hopkins as a biology student, with geology as his minor subject, and he received from there his doctorate in 1893, at the age of twenty-six. Due, perhaps, to the new and undiscovered world which his teacher and friend, G. H. Williams, showed him in rocks, he centered his interest on geology and especially on rocks. With this background and interest he developed his life's scientific activities around the study of the Precambrian geology of the Lake Superior region.

In 1899 he came to Northwestern University to fill the chair of geology, which had just been organized. At the time of his entrance on his major life's work at Northwestern, he found in the entire university far fewer students than are now registered in the department of which he was head. He was repeatedly reelected on the most important committees and was known, even to those who differed from him as to policies to be pursued, for his fairness and his honesty of purpose. In two separate occasions, for brief periods, he was called to the deanship. Therefore, to many on the campus he was always known as Dean Grant.

Upon his graduation from Johns Hopkins, Dr. Grant served as assistant state geologist of Minnesota until going to Northwestern. During the latter two years of this period, he was also on the geology staff of the university. Later, he served on other state surveys also, including Wisconsin, Oregon and Illinois. For the United States Geologic Survey he carried on studies in Alaska, Illinois, Oregon, Wisconsin and Wyoming. He was unusually well informed on the geology of the Lake Superior region, to which he made many enduring contributions.

At meetings of the various scientific societies Dr. Grant was a familiar figure, and he prized the friendships that in this way he could renew. He served successively on a number of committees of the Geologic Society of America, the Society of Economic Geologists and the American Institute of Mining Engineers. He was also vice-president of Section E of the American Association for the Advancement of Science in 1915, and was associate editor of the *American Geologist* from 1897 to 1905. Unstintingly did he lend his energies to further scientific projects at every opportunity, and was always active in the dissemination of scientific information in and about Evanston. At the time of his death he was a member of the board of directors of the Chicago Geographical Society.

Very probably his greatest and most enduring contribution was his imprint on the lives of his students and junior associates. Many men now prominent owe much of their success to his kindly stimulus, which continued to manifest itself in his voluminous correspondence. His friendships for and interest in his students and close associates in his work dominated his life completely. To him geology was a living thing, like a friend, not a text-book subject. It was an important part of the "great out-of-doors," where he was always at his best, not only with rocks but with birds and trees and the beauty and freshness of nature.

Dr. Grant is survived by his wife, two daughters and two sons. His friends, now so widely scattered, will sympathize with his family and share in their profound loss.

W. H. HAAS

NORTHWESTERN UNIVERSITY

HAROLD JACOBY

PROFESSOR JACOBY, who died on July 20, 1932, was born in New York City on March 4, 1865. He received an A.B. degree from Columbia University in 1885 and a Ph.D. in 1896. Jacoby took part in the United States Eclipse Expedition to West Africa, 1889–1890, and subsequently became a voluntary assistant at the Cape of Good Hope Observatory. There he married Annie Maclear, daughter of George Maclear, chief assistant at the Cape Observatory and granddaughter of Sir Thomas Maclear, who was for many years Astronomer Royal at the Cape of Good Hope.

In 1890, Rutherford gave, along with his instrumental equipment, his valuable series of astronomical photographs and measurements to Columbia University. Jacoby reduced the plates on the Pleiades, and several other regions were reduced under his direction. The method of determining accurate star places by means of photography, which was then in its infancy, is at present regarded as the only satisfactory method to obtain positions of high accuracy for large numbers of faint stars. Jacoby was among the few astronomers of his time who realized the importance of this method.

Jacoby took part in the observations and especially in the reduction of the variation of latitude. He also investigated the effect of optical distortions of the objective on photographic measurements.

With a few others Jacoby founded the Mathematical Society of New York, serving as treasurer and editor of its *Bulletin*, which group later on became the American Mathematical Society. At that time there existed no astronomical society and several astronomers were members of the mathematical society.

Jacoby had a very strong personality, and his exceptional conversational power was outstanding. He was much sought after for public lectures and popular scientific articles. He taught astronomy and navigation in Columbia University from 1891 to 1929, and his text-books on these subjects were widely used.

Professor Jacoby is survived by Mrs. Annie Maclear Jacoby, his son, Maclear Jacoby, his daughter, Eve Jacoby Van de Water, and two grandchildren.

COLUMBIA UNIVERSITY JAN SCHILT

RECENT DEATHS

DR. JUNE E. DOWNEY, professor of psychology and philosophy at the University of Wyoming, died on October 11, at the age of fifty-seven years.

DR. OLIVE M. LAMMERT, professor of chemistry at Vassar College, died suddenly on October 10, at the age of thirty-eight years.

H. C. CHADWICK, honorary lecturer in marine biology in the University of Liverpool, died on September 10, at the age of sixty-eight years.

DR. J. STUART THOMSON, senior lecturer and demonstrator in zoology in the University of Manchester, died on August 28, at the age of sixty-four years. Dr. Thomson was a brother of Dr. J. Arthur Thomson.

THE deaths are announced in *Nature* of Dr. J. A. Chubb, formerly curator of the Liverpool City Museum; of S. Williamson Wallace, formerly director of the Egyptian Government College of Agriculture and director of agriculture for the State of Victoria, and of Dr. A. Wilmore, formerly lecturer in geography at the Westminster Training College and principal of the Technical School, Colpe.

SCIENTIFIC EVENTS

DEGREES FROM EUROPEAN MEDICAL SCHOOLS

DR. HAROLD RYPINS, secretary of the State Board of Medical Examiners, announced on September 19 that American medical students now studying at certain medical schools in Europe or entering these schools this fall would be ineligible to practice in New York State.

With the announcement he made public a list of foreign medical schools from which graduates matriculating prior to January 1, 1933, will be eligible for license in New York State. After that date the graduates of the schools listed will not be accepted unless these schools obtain full recognition by the State Department of Education.

The list of thirty-seven includes all the medical schools of France, Italy and Switzerland and three in Scotland.

The complete list follows:

France—Universities of Lille, Lyon, Nancy, Paris, Strasbourg, Toulouse and Montpellier.

Italy—Universities of Bologna, Cagliari, Catania, Florence, Genoa, Messina, Milan, Modena, Naples, Parma, Padua, Palermo, Pavia, Pisa, Rome, Sassari and Sienna.

Switzerland—Universities of Basel, Bern, Zurich, Geneva, Lausanne and Neuchâtel.

Scotland—Anderson's College, Glasgow, School of Medicine of The Royal Colleges, Edinburgh, and St. Mungo's College, Glasgow.

Czechoslovakia—University of Prague.

Greece—National University of Athens.

Rumania—University of Cluj.

Turkey—University of Constantinople.

The following is a list of foreign medical schools recognized in New York State, the graduates of which will be eligible for license:

Austria—Universities of Graz, Innsbruck and Vienna.

Denmark—University of Copenhagen.

England—Universities of Birmingham, Bristol, Durham, Leeds, Liverpool, London, Manchester, Oxford, Sheffield and Cambridge.

Germany—Universities of Berlin, Bonn, Breslau, Frankfurt, Göttingen, Greifswald, Halle, Kiel, Cologne, Königsberg, Marburg, Münster, Erlangen, Munich, Wurzburg, Leipzig, Tübingen, Freiburg, Heidelberg, Jena, Giessen, Hamburg, Rostock and Düsseldorf.

Hungary—Universities of Budapest, Pecs and Szeged.

Ireland—Universities of Ireland, Cork, Dublin, Galway and Belfast.

The Netherlands—Universities of Amsterdam, Groningen, Leyden and Utrecht.

Norway—University of Oslo.

Scotland—Universities of Aberdeen, Edinburgh, Glasgow and St. Andrew's.

Sweden—Universities of Lund, Stockholm and Uppsala.

Wales—Welsh National School of Medicine.

FOREIGN GEOGRAPHIC NAMES

THE United States Geographic Board has issued its first publication devoted exclusively to geographic names in foreign countries. This "First Report on

Foreign Geographic Names" gives the proper spellings, location and brief additional information relating to nearly 2,500 of the more important names of countries, cities, provinces, rivers and other natural features in all parts of the world.

All previous decisions of the Geographic Board with reference to foreign geographic names are superseded by the new report, which contains, in its 113 pages, more than twice as many decisions as have heretofore been published.

The spellings given in the new report will be followed by all departments and establishments of the federal government, by requirement of executive orders.

Six general rules for the spelling of foreign geographical names have been adopted. These are:

1.—The names of major territorial divisions, such as countries, self-governing dominions, colonies and protectorates, shall regularly be spelled in accordance with conventional English usage.

2.—The names of geographic features (rivers, mountains, deserts, lakes, etc.) common to two or more major territorial divisions in which the official languages are different, shall be spelled in accordance with conventional English usage, but the local official form employed within a given country may be used parenthetically wherever it seems desirable, as Danube (Donau) River.

3.—Local geographic names in each country, dominion, colony, protectorate or possession, in which a Latin alphabet is habitually or alternatively used, shall be spelled in accordance with local official usage; except that in cases where there is a conventional English form which differs from the official name, the departments of the government may use either or both forms which are printed in boldface type in the decisions of the United States Geographic Board; if both forms are used together, either may be placed first, the other following in parentheses.

4.—Accents and diacritical marks shall be retained in all local geographic names in which they are commonly employed in the accepted spellings—official, if any—in the language or languages of the country concerned.

5.—Geographic names in countries which have a non-Latin alphabet (like Egypt) or no alphabet (like China), but which provide an official transliteration into Latin characters (as in post or survey services), shall be spelled in accordance with such official transliteration.

6.—Geographic names in countries which have a non-Latin alphabet (such as Greece) or no alphabet (like Japan), but which do not provide an official transliteration into Latin characters, shall be spelled in accordance with the transliteration table adopted by the United States Geographic Board. In case there is a conventional name which differs from that commonly employed in the country concerned, either the conventional name, or the transliteration of the name in local use, or both names may be employed.

TREES DISTRIBUTED BY STATE DEPARTMENTS FOR FOREST PLANTING

MORE than 100,000,000 trees were distributed by state forestry departments for forest planting last year, according to a statement given out by the U. S. Department of Agriculture. These trees were grown in state nurseries, and no privately grown trees are included in the figure.

Of the total number of trees distributed, 25,510,052 were sent out for farm planting, 38 states and two territories cooperating with the Forest Service in this activity. In addition, 52,507,690 trees were planted on state lands and 24,839,109 were distributed for planting on private forest lands other than farms. Plantings of all three classes gained nearly 30 per cent. over 1930, when the total distribution was 79,319,000 trees.

In total number of planted trees distributed for planting on all classes of lands except national forests, New York led with 41,211,500; Michigan was second with 23,871,248; Pennsylvania more than 8,000,000, and Wisconsin, Ohio and Massachusetts, more than 3,000,000 each. Indiana and Connecticut each passed the 2,000,000 mark.

Pennsylvania led in farm forest planting, with 6,028,835 trees, followed by New York with 4,800,000, Ohio with 1,743,506, Puerto Rico with 1,253,800, and Michigan with 1,238,520. Nebraska, Wisconsin, Tennessee and Indiana each sent out more than three quarters of a million trees for planting.

Of species sent out for planting in farm forests, pines and spruces were far in the lead, with more than 15,000,000 trees. Of the pines, approximately 3,800,000 were white pine, more than 8,000,000 were Scotch and red pines, and 500,000 were jack pine, planted chiefly in the northeastern states, New York, Pennsylvania, the upper Ohio valley and the Lake states. Ponderosa pine was planted in smaller lots in western and central states. Spruce and other pulpwood species totaling more than 4,000,000 trees were distributed largely in the Northeast and Lake states.

For the farms in the South, more than 2,500,000 trees were distributed, chiefly slash, loblolly, longleaf and shortleaf pines, with some pitch pine, white pine, Scotch and Austrian pines, also cypress, gum, locust, walnut, tulip and other hardwoods.

Black locust plantings numbered nearly 1,500,000 trees, Tennessee leading with 723,000. Many of the locust plantings were for the dual purpose of growing wood products and checking erosion and gullying. Black walnut plantings were extensive, Ohio putting out 68,000 trees and Iowa 55,000.

Under the Clarke-McNary law the Federal Government cooperates with the states in the production of

trees for farm forest and woodland planting. The trees are distributed through state forest agencies directly to the farmers, usually at cost. The Federal Government does not distribute planting stock for state or private lands.

FREE ILLUSTRATED LECTURES OF THE CALIFORNIA ACADEMY OF SCIENCES

THE California Academy of Sciences announces a special course of free illustrated lectures on the general subject of "The Beauties of Nature," to be given in San Francisco, at 8:00 o'clock, on the evenings of October 19 and 26 and November 2 and 9, 1932.

October 19—*Up the Amazon and Over the Andes.* An account of a trip for the collection of botanical specimens secured for the California Academy of Sciences, the University of California and other institutions. It was planned to describe topography and geography of the Amazon Basin, illustrated with numerous lantern slides. The lecture was delivered by Ynes Mexia, who after a stay of two years and a half in Brazil and on the East Coast of South America crossed the continent at its widest point from east to west.

October 26—*The Music of the Out-of-Doors.* This lecture, which will be illustrated with hand-colored slides, will have special reference to the mammal and bird life of the Yosemite region. It will be delivered by Bert Harwell, park naturalist of the Yosemite National Park, who will give his own interpretation of the songs and calls of birds, some accompanied with music on the piano.

November 2—*The Templeton Crocker Expedition of the California Academy of Sciences.* A symposium; illustrated. The authors and subjects will be: Templeton Crocker, Account of the Expedition; Captain Garland Rotch, The *Zaca* and Her Crew; Harry S. Swarth, curator of the Department of Ornithology, Birds; H. Walton Clark, assistant curator of the Department of Fishes, Tidepools and Their Inhabitants; John Thomas Howell, assistant curator of the Department of Botany, Plants; Robert J. Lanier, assistant superintendent of the Steinhart Aquarium, Live Fishes and Deep-sea Dredging; E. P. Van Duzee, curator of the Department of Entomology, Insects; Dr. Albert E. Larsen, medical officer of the expedition, Plankton and Termites.

November 9—*Glaciation of the Sierra Nevada.* During the Ice Age there was an extensive ice cover on the Sierra Nevada which at some points extended far down the western slope of the range. Information relating to these California ice fields and the resulting glaciation will be presented with illustrations by Dr. Eliot Blackwelder, professor of geology at Stanford University. Dr. Blackwelder was, for a number of years, a geologist in the U. S. Geological Survey. He was a member of the Carnegie Expedition to China in 1903–1904 and had been professor of geology at several middle west universities before going to Stanford in 1922.

These lectures are in continuation of three earlier courses of four each on the same general subject, given under the auspices of the academy in April, and in September and October, 1931, and in May and June, 1932.

NINTH INTERNATIONAL CONGRESS OF THE HISTORY OF MEDICINE

THE Ninth International Congress of the History of Medicine was held at Bucharest from September 10 to 18, under the presidency of Dr. Victor Gomoiu, with King Carol, who opened the congress, as president of honor.

The British Medical Journal reports that the principal themes for discussion were the evolution of medicine in the Balkan countries, a subject to which papers were contributed, among others, by the President, Dr. Galip Ata, of Stamboul; Professor A. Kousis, of Athens; Dr. Ali Milhali, of Valona; Professor P. Stoyanoff, of Sofia; Professor L. Thaller, of Zagreb, and Professor V. Bologa, of Cluj; the protection of Europe against the plague, which was illustrated by papers from Professor Ricardo Jorge, of Lisbon; Professor J. Guiart, of Lyons; Professor P. Capparoni, of Rome; Professor D. Giordano, of Venice; Professor Simonini, of Modena; Professor G. Sticker, of Würzburg; Dr. Tricot-Royer, of Antwerp, and Dr. L. Zembrzuski, of Warsaw; as well as a variety of miscellaneous topics, including an address on the history of medicine and scientific criticism by Professor A. Castiglioni, of Padua; the development of operative gynecology, by Dr. I. Fischer, of Vienna; Cruveilhier and modern medicine, by Dr. E. Goldschmid, of Frankfurt; the history of spectacles, by Professor W. Reis, of Lemberg; Polydore Vergil, by Dr. J. F. Fulton, of Yale University, and Chaucer and medieval medicine, by Dr. J. D. Rolleston, the delegate of the British Government and the Royal Society of Medicine, who, with other national delegates, was elected an honorary member of the Rumanian Society of the History of Medicine and presented with the Rumanian Order of Cultural Merit (Class II).

Visits were paid to the Faculty of Medicine, Professor Cantacuzène's institute of serums and vaccines, Professor Minovici's medico-legal institute, various hospitals and museums, the State Archives, and the Tomb of the Unknown Soldier, where a wreath was deposited. The visitors were entertained throughout their stay with lavish hospitality by the public authorities and private individuals. The last three days were reserved for a motor excursion through some of the most beautiful parts of Rumania in the neighborhood of Bucharest, with visits to Sinaia and the oil wells of Campine.

A section of the Congress of the History of Sciences, to be held at Warsaw next year, will be devoted to the history of medicine, so that the next congress of the International Society of the History of Medicine will not be held until 1935, when the meeting place will probably be Madrid.

SCIENTIFIC NOTES AND NEWS

AN Associated Press dispatch reports that the Prussian Academy of Sciences has agreed to grant Professor Albert Einstein leave of absence each year to permit him to become head of the department of mathematical physics of the Institute of Advanced Study at Princeton, New Jersey, providing he spends the remainder of each year in Germany. Dr. Einstein will take up his work at the institute in 1933. He plans to sail for America in December to reside for a time at Pasadena.

DR. JACQUES HADAMARD, professor of mathematics at the Collège de France and a member of the Institute of France, plans to visit the United States in the spring.

PROFESSOR JULIAN S. HUXLEY, the English biologist, has arrived in New York. While in the United States Professor Huxley will deliver a series of Lowell lectures in Boston.

DR. L. O. HOWARD, formerly chief of the Bureau of Entomology, who for the last year has been acting as an official collaborator of the bureau in Paris, has returned to Washington. His address is the Bureau of Entomology, Washington, D. C.

DR. WILLIAM TRELEASE, professor emeritus of botany at the University of Illinois, who spent last winter and the early spring in recreation and botanical work in the Canary Islands and the south of Spain, plans a similar expedition this winter to New Zealand.

DR. AUG. F. FOERSTE, who recently retired from the active teaching of physics at Dayton, Ohio, and who is now devoting his time to the study of the collections of invertebrate paleontology in the U. S. National Museum, has been tendered the honorary appointment of associate in paleontology in the department of geology.

PROFESSOR WILLIAM H. HOBBS, head of the department of geology at the University of Michigan, has been notified that a cape in MacRobertson's Land, new coast of the Antarctic continent discovered by the expedition of Sir Douglas Mawson last year, will be named "Cape Hobbs." Near by is "Cape Byrd," and a large "nunatak" or rock island in the icy land surface is "Gould's nunatak," called after Admiral Byrd's second in command, formerly at Michigan, now head of the department of geology at Carleton College. Five other glaciers or glacial features in both Polar regions have been named for Professor Hobbs. In 1911 a Swedish party named one for him in East Antarctica; another was named in South Victoria Land by the lost Scott Expedition in 1913; a fourth in East Greenland by a Swiss expedition in 1920, and a fifth by a Danish expedition in 1921 in Peary Land, Greenland.

A DINNER in honor of the sixtieth birthday of Dr. Emanuel Libman was held in New York on October 15. One hundred and forty-seven physicians and scientific men in the United States and from seventeen foreign countries honored him by personal contributions written for the occasion in three anniversary volumes, which were presented to him at the dinner. Dr. A. A. Epstein was chairman of the committee arranging the dinner. Dr. Israel Strauss presided. Among the speakers were: Dr. William H. Welch, of the Johns Hopkins University; Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research; Dr. John A. Hartwell, president of the New York Academy of Medicine; Dr. Maude E. Abbott, of McGill University; William N. Cohen, trustee of the Emanuel Libman Fellowship Fund; Dr. James Ewing, of Cornell University Medical School; Dr. Nathan Ratnoff, medical director of Beth Israel Hospital and president of the American Jewish Physicians' Committee, and Dr. Epstein.

THE British Institute of Fuel, London, has awarded the Melchett medal for distinguished achievements in industry to Charles M. Schwab, chairman of the board of the Bethlehem Steel Company.

DR. GEORGE F. DICK, chairman of the department of medicine at Rush Medical College of the University of Chicago and staff member of the John McCormick Institute for Infectious Diseases, will become chairman of the department of medicine in the Division of the Biological Sciences, a post vacant since the resignation of Dr. Russell Wilder last year.

THE resignation is announced of Dr. H. C. Biddle, director of the chemical laboratories and dean of the College of Pharmacy of the University of California. Dr. H. B. Carey, professor of materia medica, botany and pharmacognosy, will serve as acting dean of the college.

ASSOCIATE PROFESSOR R. W. HODGSON, subtropical horticulturist in the Experiment Station of the University of California, has been appointed as assistant

director of the Branch of the College of Agriculture in southern California.

HOWARD D. ROELOFS, professor of philosophy at Stanford University, who was visiting professor at Amherst College during the past year, has been appointed Wilson professor of philosophy and head of the department at the University of Cincinnati.

DR. GEORGE H. MILLER, associate professor of theory and practice of medicine, State University of Iowa College of Medicine, has been appointed dean of the American University of Beirut School of Medicine, Beirut, Syria. He succeeds Dr. St. John Ward, who has leave of absence on account of ill health.

DR. G. C. ANDERSON, deputy medical secretary of the British Medical Association since 1919, has succeeded to the post of medical secretary of the association upon the retirement of Dr. Alfred Cox.

Nature states that Miss M. R. J. Edwards has been appointed official guide-lecturer at the British Museum of Natural History in succession to the late Mr. J. H. Leonard, who died at the end of last year. Owing to the success achieved by the appointment of guide-lecturers at the national museums and galleries, it has been decided to inaugurate more advanced lecture tours to be conducted by members of the scientific staff of the museum, on Mondays at noon.

ADELAIDE SPOHN, formerly professor of nutrition at Cornell University, has recently accepted a position with the Elizabeth McCormick Memorial Fund, Chicago. She is at present director of nutrition service of the Illinois Emergency Relief Commission and the Unemployment Relief Service of Chicago.

DR. JOHN T. STEARN, who, during the past two years, has been in charge of the production department of Toledo Synthetic Products, Inc., manufacturer of "Plaskon," a urea-formaldehyde molding compound, has rejoined the research staff of the Mellon Institute of Industrial Research, at Pittsburgh, Pennsylvania, where he will be at the head of the industrial fellowship sustained by this company. Dr. A. M. Howald, formerly holder of the same fellowship, is now engaged in production research in the company's plant in Toledo, Ohio.

H. R. SEIWELL, oceanographic chemist at the Oceanographic Institution, Woods Hole, Massachusetts, who has been awarded a fellowship by the American-Scandinavian Foundation for 1932–33, has received leave of absence in order to make a study of methods of oceanographical research in Europe.

DR. LOUIS C. SCHROEDER, director of the American Child Health Association, has been appointed director of the pediatric service at the New York City Nursery and Child's Hospital, to succeed Dr. Oscar M. Schloss. The pathological laboratory at the hospital is now under the direction of Dr. Frederick A. Hemsath, formerly chief pathologist of the Lying-in Hospital.

JEAN CAPART, director of the Royal Museum of Art and History in Brussels, has leave of absence for two months beginning on January 1 to direct the reorganization of the department of Egyptology at the Brooklyn Museum. Professor Capart will assume charge under the terms of the Charles Edwin Wilbour Fund, established in May, 1931. The income from this fund, which is said to have amounted to $60,000 last year, is to be used exclusively to augment and develop the collection in Egyptology. Part of this amount has been spent "in conserving and carrying on the present collection," while part has gone to help support exploration now being carried on in Egypt. Professor Capart will give a series of lectures at the museum.

DR. JAN H. OORT, lecturer and observer at the University of Leiden, arrived in Delaware on October 4, to begin photometric studies of nebulae in a cooperative plan with the Perkins Observatory of Ohio Wesleyan University. While at the Perkins Observatory Dr. Oort will give a special series of lectures on stellar statistics on Thursday afternoons, beginning on October 13. The titles of the lectures are: "The Observational Data," "Methods for Determining Stellar Distributions," "General Structure of the System of Stars," "Stellar Motions," "Stellar Dynamics I," "Stellar Dynamics II. Galactic Rotation." The lectures and discussions are open to all interested.

THE fiftieth stated meeting of the American Ornithologists' Union was held in Quebec, from October 17 to 20. The headquarters of the meeting were at the Chateau Frontenac and the public sessions were in Laval University. The first day was devoted to business meetings, and the public sessions opened on Tuesday morning. On Friday, following the close of the regular meeting, there was an excursion to Cap Tourmente to see the snow geese which usually stop a few days on the St. Lawrence during their southward migration at this time of the year. In connection with the meeting there was an exhibit of photographs, drawings and paintings of birds to which artists in all parts of the United States and Canada were invited to contribute. This was the second meeting of the union to be held in Canada, the first one having been in Ottawa in 1926.

THE twelfth annual meeting of the Highway Research Board will be held on December 1 and 2 in the building of the National Academy of Sciences and the National Research Council, Washington, D. C.

LAWRENCE COLLEGE dedicated the new library and laboratory of the Institute of Paper Chemistry on September 21, the eightieth anniversary of the matriculation at Lawrence of J. A. Kimberly, to whom the structure was dedicated. The building, which was erected at a cost of $100,000, was given by the late Mr. Kimberly's son. It constitutes the second unit of the institute. The first, which cost $250,000, was dedicated a little less than a year ago.

NEW YORK UNIVERSITY has purchased the buildings and equipment formerly used by Cornell University Medical College fronting Bellevue Hospital, with the prospect of developing in the future a large medical center in the Bellevue Hospital area. For the present the property will be utilized by University and Bellevue Hospital Medical College for laboratory and teaching space, but the undergraduate student body will not be enlarged. New York University now owns all the land necessary for its projected health center, including all the property between Twenty-Fifth and Twenty-Eighth Streets on both sides of First Avenue.

Museum News reports that a new botanical garden at the Hebrew University, Jerusalem, will be known as the Lamport Botanical Garden, the land on which it has been established having been given to the university by Solomon Lamport, of New York. The site of the new garden is the summit and part of the slopes of Mount Scopus. One section is to be left with its native vegetation untouched; other portions will be devoted chiefly to a collection of the floras of the Near East from Iraq to Sinai and into the deserts beyond the Jordan River.

UNDER a grant received by the Smithsonian Institution, a solar radiation observatory will be established on Mount St. Katherine on the Sinai Peninsula in Egypt. This mountain is 8,600 feet high, and the atmospheric conditions are reported to be very favorable.

IT is announced that the Rockefeller Foundation has made a gift to University College Hospital, London, of £48,800 "to constitute a fund for the permanent endowment of a post, the holder of which will devote his whole energies to the advancement of clinical research." The gift is made to encourage clinical research on lines which the Medical Research Council has been developing in conjunction with University College Hospital Medical School since 1916. The object is that there should be brought into existence a body of workers, free from ordinary hospital routine and teaching, who will devote their whole time to the investigation of special clinical problems.

THE Paris correspondent of the *Journal* of the American Medical Association reports that the new laboratory created at the Faculté de Pharmacie de Paris will be under the direction of Professor Perrot, member of the Academy of Medicine, and will be devoted to research on plant life. The laboratory has been equipped with the aid of a governmental appropriation, together with more than $24,000 contributed largely by the alumni of the Ecole de Pharmacie and the large manufacturers of pharmaceutic specialties and chemical products. The laboratory was opened by the minister of public instruction at ceremonies attended by the rector of the University of Paris, and by the present dean and former deans of the Faculté de Pharmacie.

DISCUSSION

BODY SIZE AND BODY PROPORTIONS IN RELATION TO GROWTH RATES AND NATURAL SELECTION

HALDANE[1] in his suggestive little book "The Causes of Evolution," discussing the action of natural selection, says:

"In the mouse a fair percentage, generally about a quarter, of the embryos die during pregnancy. There is not sufficient space or nourishment for them all, *i.e.*, they compete with one another. Hence, in animals producing many young at a birth, there will probably be selection in favour of rapid embryonic growth, and adult characters determined by genes causing rapid embryonic growth will spread through the species. We have here a cause of unfavourable adult characters."

[1] Harper and Bros., New York, 1932.

What Haldane had in mind as rapidity of embryonic growth was probably rapidity of differentiation rather than increase in absolute size, for he goes on to specify the development of man in contrast to that of other mammals as involving "a marked slowing down of the rate of development."

Yet his principle will apply with equal force to increase in size, irrespective of the rate of differentiation, and to postnatal as well as to prenatal competition.

Gregory and I[2] have recently shown that, in rabbits, increase in racial size is attended by (and presumably caused by) an increased rapidity of growth, both prenatal and postnatal, although the rate of differentiation and the initial size of the egg remain unchanged.

A mutation tending to increase the growth rate would, in such cases, tend to increase the size at birth

[2] *Jour. Exp. Zool.*, 59, 1931.

and at maturity. It would favor the most rapidly developing zygotes, not only in the embryonic period—where crowding might occur, as Haldane points out, but also during lactation, and even subsequently. I have sometimes tried to rear, with the aid of a common foster mother, rabbits born on the same day to large race and small race mothers, but usually without success, because the large race young are so much heavier and stronger that they push the small race young away from the nipples and monopolize the milk supply. But if the two sorts of young are put to separate foster mothers, both lots thrive. Similar considerations make it impracticable to pen large race and small race rabbits together, after they are weaned.

There can accordingly be no doubt that large body size is an advantage to the individual in competition with other individuals in early life. Whether it would remain such in adult life would depend upon numerous environmental agencies. It might turn out, under some conditions, to be a positive handicap, as when hunters kill only animals above a minimal size.

Students of paleontology record the observation that the earliest mammals were small, and that in various lines of descent the size of the individual has increased, and that the attainment of maximum size has usually preceded extinction. This has been true, not alone in the case of mammals but also in that of birds and reptiles. This has been regarded by some as evidence of an orthogenetic tendency quite apart from fitness. Haldane rightly emphasizes the point that the final stage may be positively disadvantageous and so lead to extinction, though it is only a consequence of a prenatal or juvenile contest, in which larger size assured victory.

Another supposed orthogenetic tendency, involving a change in proportions, has been shown repeatedly to be only an indirect consequence of change in absolute size. This fact is emphasized (though it was not first discovered) by Julian Huxley in his recent book on "The Principle of Relative Growth."[3] A rabbit (or any other mammal), as it grows, increases in *length* of body, tail, ears and legs, faster than it grows in *width* of the same parts. Thus its skull, leg bones, etc., become steadily more slender in their proportions, as the absolute dimensions increase. The same relation holds between the final or adult stages of races of different body size. The larger race has the more slender form. And we need not confine the comparison to races within a single species. Compare, for example, the huge jack rabbit with the little cottontail which lives on the same prairies. Or compare the long-headed modern horse with the small-bodied species which flourished in Eocene times.

[3] The Dial Press, New York, 1932.

A supposed orthogenetic tendency to change the proportions in a certain direction is probably, in reality, only a consequence of increased body size, which, in turn, may be a consequence not of orthogenesis but of the competition, within the same species, between embryos with slightly different developmental growth rates.

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THE TUBERCLE BACILLUS

IN a recent note in SCIENCE,[1] Professor Hastings and Dr. McCarter protest the use of the term "tubercle bacillus" as applied to an organism used in recent studies in this laboratory and in two American laboratories. At the same time they present a description of the species they consider will permit only the inclusion of the true bacillus of Koch. While the description is in many respects a conventional one, it appears unwise at the present time to exclude, by definition, organisms which many students of the group regard as tubercle bacilli and at the same time to make the limits so narrow as to deny the application of the dissociation phenomenon to the species. The description of the species suggested by Professor Hastings and Dr. McCarter appears to do both.

Several features of this definition of the species is out of line with recent work. Probably the authors intend it to be controversial. Exception may be taken particularly to the defined pathogenicity. It seems quite reasonable to "regard as tubercle bacilli only those which, when introduced into the body of a susceptible animal, such as the guinea pig produce tuberculous lesions inoculable in series." Professor Hastings and Dr. McCarter quote this from Calmette, and yet such a limitation will exclude from the species the important bacillus of Calmette and Guerin (BCG) since, in its most characteristic form, it can not be regarded as inoculable in series. For the same reason this portion of the definition will exclude R forms of tubercle bacilli from the species, notwithstanding the fact that such experienced workers as Petroff, Medlar, Kahn in America, Begbie in Britain, Uhlenhuth, Seiffert in Germany advance many evidences of the origin of such forms as variants of the more characteristic types.

This definition excludes another important variant of the tubercle bacillus when it states that growth occurs "only on the surface of liquid media and the inoculum must be floated on the surface." Dreyer and Vollum[2] have recently shown that variants, in

[1] E. G. Hastings and J. McCarter, SCIENCE, n. s., 75: 512, 1923.

[2] G. Dreyer and R. L. Vollum, *Lancet*, I, 9, 1931.

other respects characteristic tubercle bacilli, may be grown in the depth of culture fluids, an observation which we[3] have just confirmed and extended.

In our papers,[4] which the authors quote among their examples of "misnamed cultures and studies of the tubercle bacillus," we demonstrated that a series of cultures of tubercle bacilli recently isolated from active tissue lesions and cultures with a history of maintained virulence exhibit certain characteristics, characteristics which without question place them as belonging to the species. Certain of these have been shown to dissociate into avirulent forms which exhibit certain characteristics at variance with the classical definitions. These observations are in agreement with and in extension of the work of the authors mentioned in the previous paragraphs. At the same time, we pointed out that a series of avirulent cultures and cultures with a history of loss of virulence exhibit characteristics which relate them to the forms known to have arisen by dissociation from characteristic tubercle bacilli. Professor Hastings and Dr. McCarter advance interesting historical evidence that one of the latter should be regarded as an acid-fast saprophyte rather than a tubercle bacillus.

Work of the last decade has established beyond cavil the fact that bacteria are subject to variation. Variation of the tubercle bacillus is imperfectly understood, but the results and theories so far advanced are in complete agreement with the more extensive data accumulated concerning other groups. Studies of the tubercle bacillus will not be promoted by defining the species in such conservative terms as to exclude the variants which we observe.

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THE SWARMING OF ANTS

ON Sunday afternoon, September 4, 1932, as I was returning from a walk in the country, I noticed several winged ants (*Tapinoma humilis*) in the air. By the time I reached home, there were great swarms of them everywhere. I examined my front lawn, and found great excitement among the ant colonies. Workers, winged queens and winged males were running here and there around their entrances. The entire lawn was a seething mass of ants. The winged forms were rapidly leaving the ground, and taking to the air.

On my coat I found many males, apparently exhausted and unable to fly away when I tried to shake them off. They had mated with some flying queen a few minutes before, I assumed. Before an hour had passed, I noticed numerous males on the ground, helpless, and apparently dying. Some were being dragged away by workers, which appeared to be attacking the males as though helping to kill them.

At the end of another hour there were many mated queens crawling about on the ground and on the grass blades. As I watched them, I found several in the act of tearing off their own wings. They had evidently mated while in flight, and were now ready to settle down to their business of rearing a family. Soon there were countless queens stripped of their wings crawling about everywhere, seeking new homes. There were also many queens which did not tear off their wings.

As darkness approached, the air cleared up, and no more flying honeymoons were in evidence. The excitement of the colonies was dying down, and the queens were disappearing in various crevices and holes. There were still many males crawling about in a semi-stupor. A careful look over the surface of the ground revealed hundreds of delicate wings which had been shed by the mated queens. As darkness fell, all was again quiet.

My attention was first called to the flying ants about three o'clock in the afternoon, Central Standard time. Their numbers seemed to be greatest between four and five o'clock, and by six o'clock, the affair was waning. By seven-thirty, all was quiet. I inquired to find out whether this swarming was very extensive, and learned that it covered most of this state as well as adjoining states. I do not know how much farther it extended. Tourists stopping at the gasoline stations that same evening, reported having driven through swarms of them for several hours over a distance of a hundred miles or more.

The next morning I examined my lawn again, and found no indications of the previous day's rendezvous, aside from the many wings scattered about like the remains of some aeronautic battle. A few wingless queens were found, and a number of dead males were uncovered. The workers had apparently cleared away the débris as much as possible. All was peaceful and industrious. Life had once more settled down to routine matters.

JOHN H. FURBAY

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THE GROWTH OF STALAGMITES

THE brick part of Fort Morgan (at the mouth of Mobile Bay, Alabama), where the data in this communication were observed, was built in 1855. Active use was made of this portion of the fort until after the Spanish-American War, when it was abandoned.

[3] G. B. Reed, *Canadian Journal of Research*, in press.
[4] G. B. Reed and C. E. Rice, *Canadian Journal of Research*, 4: 389, 1931; 5: 111, 1931.

The rooms containing the stalactites and stalagmites are similar to those described by Professor Ellis in SCIENCE for January 16, 1931. The roof and walls are four feet thick and are made of brick set in lime mortar. The roof is covered with vegetation, as at Fort Pickens. Apparently the date of construction, the date of abandonment and the climatic conditions agree with the corresponding elements in the situation at Fort Pickens, which is fifty-five miles due east on the shore of the Gulf of Mexico.

At the time of my last visit water was still dropping very slowly from the ceilings—the result of a recent torrential downpour caused by a hurricane. Scores of stalactites were noted in each of a dozen rooms, the longest being eight inches. The caretaker said that tourists break off the longest. The stalactites are about the thickness of a lead pencil, are hollow inside and quite frail.

On the floors were noted a number of stalagmitic deposits, broad and low in make-up, overlying the charred remains of roof-timbers and window-casings that the caretaker said had fallen as a result of a fire in the year 1930. The largest stalagmitic deposit seen on a charred timber was three fourths of an inch high and eight inches in diameter. Hence it would seem that it had grown three fourths of an inch in two years.

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SCIENTIFIC MEETINGS

THE SIXTH INTERNATIONAL CONGRESS OF GENETICS

THE sixth International Congress of Genetics was held from August 24 to 31, inclusive, at Cornell University, Ithaca, N. Y. The registered members numbered about 700, of which 550 were in attendance. In spite of adverse economic conditions there was a representative and distinguished group of European geneticists on hand.

Official delegates from foreign governments were as follows: *Belgium:* M. le Prof. L. Frateur and M. le Prof. R. Vandendries; *Chile:* Señor Don Manuel Elgueta y Guerrin; *Denmark:* Prof. Dr. Ojvind Winge; *Finland:* Prof. Harry Federley; *France*: M. le Prof. A. Vandel; *Great Britain:* Professor R. Ruggles Gates, Ph.D., F.R.S., and Professor. F. A. E. Crew, D.Sc., Ph.D.; *Italy:* Prof. Alessandro Ghigi, Prof. Cesare Artom, Prof. Fabio Frassetto, Prof. Corrado Gini and Prof. Carlos Jucci; *Norway:* Prof. Dr. Otto Lous Mohr; *Spain:* Señor Don Antonio de Zulueta y Escolano.

The program consisted of a series of invitation papers on special topics; contributions from members of the congress either as papers or exhibits; meetings of the congress as a whole in two plenary sessions, as well as of various groups interested in special topics; and social events.

The morning sessions numbered five with the following programs:

1. *General Genetics:* Professor T. H. Morgan, *chairman*
   (a) "Mendelism in Man," Dr. C. B. Davenport, Cold Spring Harbor, N. Y.
   (b) "Inheritance of Educability," Dr. F. A. E. Crew, Edinburgh.
   (c) "The Use of Mosaics in the Study of the Developmental Effects of Genes," Dr. A. H. Sturtevant, Pasadena.
   (d) "The Present Status of Maize Genetics," Professor R. A. Emerson, Ithaca, N. Y.
2. *Mutations:* Dr. C. B. Davenport, *chairman*
   (a) "On the Potency of Mutant Genes and Wild-type Allelomorphs," Dr. O. L. Mohr, Oslo.
   (b) "Mutations of the Gene in Different Directions," Dr. N. Timoféeff-Ressovsky, Berlin-Buch.
   (c) "The Genetic Nature of Induced Mutations in Plants," Professor L. J. Stadler, Columbus, Missouri.
   (d) "Further Studies on the Nature and Causes of Gene Mutations," Professor H. J. Muller, Austin, Texas.
3. *The Interrelations of Cytology and Genetics:* Dr. R. Ruggles Gates, *chairman*
   (a) "The Cytological Basis for Crossing-over," Dr. Karl Sax, Forest Hills, Mass.
   (b) "Neuere Ergebnisse über die Genetik und Zytologie des Crossing-over," Dr. Curt Stern, Berlin-Dahlem.
   (c) "The Nature of Sex-chromosomes," Dr. O. Winge, Copenhagen.
4. *Genetics of Species Hybrids:* Dr. W. E. Castle, *chairman*
   (a) "The Species Problem in *Datura*," Dr. A. F. Blakeslee, Cold Spring Harbor, N. Y.
   (b) "Konjugation der artfremdea chromosomen," Dr. H. Federley, Helsingfors.
5. *Contributions of Genetics to the Theory of Organic Evolution:* Dr. R. Goldschmidt, *chairman*
   (a) "Genetik der geographischen Variation," Dr. R. Goldschmidt, Berlin-Dahlem.
   (b) "The Process of Evolution in Cultivated Plants," Dr. N. Vavilov, Leningrad.
   (c) "The Evolutional Modification of Genetic Phenomena," Dr. R. A. Fisher, Harpenden.
   (d) "Can Evolution be Explained in Terms of at Present Known Genetical Causes?" J. B. S. Haldane, Merton.

(e) "The Rôles of Mutation, Crossbreeding, Inbreeding and Selection in Evolution," Professor S. Wright, Chicago, Ill.

Among the features of the general program, the exhibition garden of live plants was outstanding. The preparation of all exhibits was under the general direction of Dr. M. Demerec. The garden was especially under the care of Dr. R. A. Emerson and members of the department of genetics at Cornell University. It included the main types of genetical interest in *Antirrhinum, Impatiens, Linum, Lycopersicum, Medicago, Melandrum, Nicotiana, Oenothera, Papaver, Petunia, Pharbitis, Phleum, Pisum, Raphanobrassica, Soja, Solanum, Sorghum,* Sunflower, *Vicia, Viola* and *Zea,* as well as plots showing disease resistance, floriculture and a collection of garden vegetables.

Other exhibits shown in the various rooms and laboratories numbered 15 types of invertebrate and 11 types of vertebrate animals, 4 types of lower plants, 31 types of higher plants, 13 types of garden vegetables and 20 types in the floricultural group. There were also exhibits dealing with fruit genetics and breeding, coffee, improvement of cultivated plants, tree breeding for timber production, varieties recommended by State Crop Improvement Associations, general cytology, cytology of *Triticum, Hordeum* and *Avena,* materials for elementary laboratory courses in genetics, pure cultural methods, quantitative phylogeny, radiation and genetics, and an international auxiliary language. A total of approximately 370 individual exhibits were listed.

In addition, over two hundred papers were included in the general program. These were presented on three afternoons in the following number of sectional meetings: General Genetics 2, Cytology 3, Animal Genetics 2, Human Genetics, Methods and Technique, Genetics and Phytopathology, Plant Genetics 2, Chromosome Structure and Crossing-over, Genetics of Species Hybrids, Drosophila, Problems Relating to Sex and Fertility, Genetics and Pathology. The chairmen of these sections included the following: Dr. E. C. MacDowell, Professor C. E. Allen, C. Jucci, Professor S. J. Holmes, J. Clausen, R. Vandendries, Dr. C. W. Metz, J. Hammond, S. C. Harland, C. D. Darlington, H. Federley, Dr. G. H. Shull, Professor B. M. Davis, M. Skalinska, Dr. A. H. Sturtevant, H. Nachtsheim, and Dr. F. A. E. Crew. The program was in charge of Dr. E. M. East as chairman of the program committee.

Special groups interested in sire valuation, corn genetics, mouse genetics, human heredity, poultry linkage and gene problems met for one or more informal evening sessions.

On Wednesday, August 21, the congress members visited the New York Agricultural Experiment Station at Geneva, New York. Here the program included an address of welcome by Professor U. P. Hedrick, a section on fruit and vegetable breeding, exhibits of fruit breeding, vegetable breeding, physiology, cytology, bacteriology, chemistry, animal breeding, entomology and publications. Five outdoor tours were also conducted. After a dinner and entertainment, the members returned to Ithaca.

On August 24, the opening day, the first plenary meeting was held. This was followed by an informal reception at Willard Straight Hall. In the receiving line were Provost A. R. Mann, of Cornell University, and all the members of the executive council of the congress.

At the plenary session it was decided to leave to the *ad interim* committee, to be elected at the final plenary session, the choice of the meeting place of the seventh congress to be held in 1937. A nominating committee, with Dr. T. H. Morgan as chairman, was also appointed to bring in names for the personnel of the *ad interim* committee. Two other committees were elected; one on resolutions with H. Federley as chairman and one on greetings to absent colleagues with Dr. G. H. Shull as chairman.

On August 25 a general meeting was held in the evening. The program consisted of organ music by F. S. Andrews, assistant university organist of Cornell University, an address of welcome by Provost A. R. Mann, a response by Dr. Richard Goldschmidt and the presidential address on "The Rise of Genetics," by Dr. T. H. Morgan.

At the final plenary session an *ad interim* committee to serve until the 1937 Congress was selected as follows:

Austria, E. von Tschermak-Seysenegg
Belgium, René Vandendries
Denmark, ö. Winge
Finland, Harry Federley
France, Roger de Vilmorin
Germany, Richard Goldschmidt
Great Britain, J. B. S. Haldane
Holland, Tinne Tammes
Italy, Alessandro Ghigi
Japan, Seiitiro Ikeno
Norway, Otto L. Mohr
Sweden, H. Nilsson-Ehle
Switzerland, Otto Schlaginhaufen
Union of Socialist Soviet Republics, N. Vavilov
United States of America, R. A. Emerson

The following official delegates from institutions and societies were presented to the congress:

Argentina:
University of Buenos Aires, S. Horovitz,

Brazil:

Agronomical Institute of the State of Campinas, Carlos Arnaldo Krug.

British Empire:

Canada: University of Laval, Monsieur l'Abbe Maurice Proulx; University of Montreal, M. le Prof. Henri Prat.

West Indies: The Empire Cotton Growing Corporation, Dr. S. C. Harland.

France:

Ministry of Public Instruction, M. le Prof. Henri Prat.

Germany:

German Genetics Society, Prof. Dr. R. Goldschmidt.

Kaiser Wilhelm Society for Advancement of Science, Prof. Dr. R. Goldschmidt.

Holland:

Dutch Genetical Society, Miss Dr. J. A. Leliveld.

Italy:

Central Institute of Statistics of Italy, Prof. Corrado Gini.

Committee for the Study of Population Problems, Prof. Corrado Gini.

Italian Society of Genetics and Eugenics, Prof. Corrado Gini, Prof. Cesare Artom and Prof, Alessandro Ghigi.

Ministry of National Education, Prof. Alessandro Ghigi, Prof. Corrado Gini and Prof. Cesare Artom.

Norway:

University of Oslo, Prof. Dr. Cristine Bonnevie.

Poland:

Free University of Poland, Mrs. M. Skalinska, Ph.D.

United States of America:

Department of Agriculture and Commerce, Puerto Rico, Arturo Roque.

National Institute of Social Sciences, Albert F. Blakeslee, Ph.D.

University of Florida, B. A. Bourne.

On recommendation of the committee on greetings, messages were sent to the following geneticists: E. Baur, C. Correns, K. Pearson, E. von Tschermak-Seysenegg, H. de Vries, E. B. Wilson. Greetings were also sent to the vice-presidents not attending. These included A. H. Buller, H. Nilsson-Ehle, E. Malinowski, L. Cockayne, Y. Tanaka, L. Cuénot, D. Paolo Enriques, V. Gregoire and A. Ernst.

On recommendation of the committee on resolutions, the following action was taken: Votes of thanks to Cornell University, the local committee and to the members of the organization committee and executive council. A resolution that the congress approves the suggestion of Professor Tinne Tammes that the problem of standardizing genetic symbolism and nomenclature should be reconsidered and that the Genetic Societies of all countries concerned are asked to appoint committees which shall cooperate and prepare recommendations to be published two years before and to be discussed at the next International Genetics Congress.

The social program included an interesting and adequate series of events for visiting ladies. There were also excursions to spots of scenic beauty near to Ithaca, such as Watkins Glen, Enfield Glen and Taughannock State Park. At the latter an outing and picnic supper attended by 800 were held.

In spite of difficulties encountered in financing the congress, it appeared to be the general consensus of opinion that the occasion as a whole was extremely successful. Columbia University, the Carnegie Corporation, the Carnegie Endowment for International Peace, as well as the many institutions and individuals who contributed, all deserve their share of credit for making the congress possible.

Dr. Otto Mohr was asked to serve as chairman of the *ad interim* committee and to initiate the discussions within the committee concerning the place at which the next congress would be held. It was understood that full authority to settle this question is delegated to this committee, which is to act as representative of the international congress as a whole and is to reach its decisions without special consideration for the countries represented by its chairman or members. When it has reached a decision, it will transfer its functions to a committee to be formed by the country in which the Seventh International Congress of Genetics is to be held.

C. C. LITTLE,
Chairman of the Executive Council and Secretary-General of the Sixth International Congress of Genetics.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

SUCCESSFUL CAGE REARING OF ANOPHELES QUADRIMACULATUS[1]

Two years ago the result of efforts to establish a perpetuating colony of *Anopheles quadrimaculatus* in an insectary was reported.[2] While small numbers of fertile ova were secured from cage-reared parents, the work was not deemed a success, inasmuch as reproduction in the insectary took place at a diminishing rate, which was bound to result in the early extinction of the strain employed.

Recently, in conjunction with studies of induced malaria, efforts to rear anophelines were resumed,

[1] The studies and observations on which this paper is based were conducted with the support and under the auspices of the International Health Division of the Rockefeller Foundation.

[2] Boyd, *Am. Jour. Trop. Med.*, X, 165. 1930.

primarily to supply a stock of mosquitoes known to be free from naturally acquired malaria infection. The insectary employed differs radically in several respects from the one previously used. The new structure has not as yet been described, although the essential features of its operation are discussed in a paper by Boyd and Cain entitled "On Large-scale Rearing of *Anopheles quadrimaculatus* in Captivity," to appear in an early number of the *American Journal of Hygiene*."

The operation of the new insectary resulted in the production of five successive lineal generations of *A. quadrimaculatus* between February 18 and July 17, 1932; and multiplication in each generation occurred at an increasing rate. The periods over which the different stages of each generation were current are listed below. In several instances they were artificially curtailed to meet the exigencies of insectary operation incident to the production of stock for infection

Five Successive Generations of *A. quadrimaculatus* Produced between February 18 and July 17, 1932.

I. Ova	From insectary females, deposited prior to February 18, 1932
Larvae	February 18 to March 30
Imagines	February 22 to April 1
II. Ova	March 20 to April 19
Larvae	March 30 to April 26
Imagines	April 14 to May 14
III. Ova	May 6 to May 22
Larvae	May 6 to June 10
Imagines	May 19 to July 8
IV. Ova	May 24 to July 7
Larvae	May 26 to present (July 22)
Imagines	June 15 to present (July 22)
V. Ova	July 17 to present (July 22)
Larvae	July 17 to present (July 22)

and to our desire to avoid the mixing of adult females of different generations.

Over the three months' period from November, 1931, to February 18, 1932, the insectary was operated solely from the standpoint of furnishing stock for infection purposes. This stock was reared from the ova of wild females, and we have reason to believe that during this period, when no effort was made to keep the generations separate, there actually occurred three further generations. When it became apparent that abundant propagation was taking place in captivity, the insectary operation was modified in order to disclose each generation and to avoid the mixing of females of two generations. However, since the operation of the insectary prior to February 18 did not permit us to distinguish generations clearly, the possibilities of that period are ignored in this chronology.

The production of fertile ova is sufficient proof of the occurrence of copulation. As many larvae as our facilities permit are reared according to the methods described in the paper by Boyd and Cain. The imagines produced compare favorably in size with wild individuals. Males are fed on raisins, while the females feed readily on the person of the attendant, their only blood supply.

While the hazards of the future can not be forecast, there is nothing in the present outlook to indicate any limitations to the indefinite propagation of this strain. Needless to say, the possession of this strain is of the greatest advantage in the transmission of naturally induced malaria and offers research opportunities hitherto unavailable.

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SPECIAL ARTICLES

STIMULATION OF SPAWNING AND CROSS-FERTILIZATION BETWEEN AMERICAN AND JAPANESE OYSTERS

IT has been shown previously by one of the authors that spawning of male and female American oysters, *Ostrea virginica,* can be induced by the sexual products of the opposite sex. The reaction appeared to be specific in the sense that sperm of other molluscs (Mytilus, Mya) had no effect on oysters. Negative results were obtained also in attempting to stimulate the ripe males of *O. virginica,* grown in Honolulu, by the eggs of *O. cucullata,* a species introduced from Australia.

This summer the authors have experimented with a Japanese oyster, *O. gigas,* which was imported as seed from Japan, grown for about two years in Puget Sound and shipped in April, 1932, to Woods Hole, Mass.

Both *Ostrea virginica* and *O. gigas* can be stimulated by the sperm or eggs of either species. Thus, the spawning reaction of female *O. virginica* can be provoked by adding sperm of *O. gigas,* and similarly a female *O. gigas* responds to the presence of sperm of *O. virginica.* Spawning of the males is equally well provoked by the addition of eggs or egg water of either species.

Table 1 shows that in females the latent periods of spawning reactions vary from 8 to 26 minutes, while in the males the variation is from 4 to 6 seconds. In both cases the latency is within the limits previously observed in spawning *O. virginica* and apparently independent of the kind of eggs or sperm used

TABLE 1

LATENT PERIODS OF SPAWNING REACTIONS OF FEMALE OYSTERS

Female	Male	Temp. °C.	Lat. per. mins.
O. virginica × *O. virginica*		23	9
"	"	23	20
"	"	23	21
"	"	23	24
O. virginica × *O. gigas*		22	15
"	"	22.5	17
"	"	23	26
O. gigas × *O. gigas*		27.5	15
O. gigas × *O. virginica*		27	9.5
"	"	27	8.0

for stimulation. This may indicate that the sexual products of both species possess similar active principles which induce the spawning reactions.

Eggs of both species were easily fertilized by either sperm, the ensuing development resulting in apparently normal straight hinge larvae. Comparison with controls showed no increased mortality among the hybrids.

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R. O. SMITH

U. S. BUREAU OF FISHERIES

THE STRUCTURE OF CHROMOSOMES OF ZEA MAYS AS REVEALED BY THE FEULGEN REACTION

DURING the progress of a series of studies on the microchemistry of the nucleolus, the Feulgen reaction for thymonucleic acid[1] was applied to root-tips of *Zea mays* fixed according to Zirkle[2] in a solution of sulfuric acid 2 cc, formalin 10 cc, distilled water 90 cc, with a pH of < 1.0.

Staining with haemotoxylin after the above fixative, Zirkle found the chromatin reticulum and periphery of the later spireme and of the chromosomes stained blue, while the nucleoli and "core" of the spireme and of the chromosomes remained colorless. He also describes a physical connection between the nucleolus and the spireme.

Feulgen staining bears out the haematoxylin demonstrated morphology to a startling degree. In the resting cell and early prophase, chromatin granules, chromatin reticulum and spireme are stained a solid, intense reddish-violet; as mitosis progresses and the diameter of the spireme increases, a minute canal appears within the spireme and extends its full length. The appearance of this canal or "core" is accompanied by a decrease in the size of the nucleolus; as the spireme increases in cross-section, there is a corresponding increase in the size of its "core" and a decrease in the amount of nucleolar material visible.

The late prophasic chromosomes have the appearance of tubules of almost uniform bore; the nucleolus may disappear entirely or vestiges may remain to follow the chromosomes to the equatorial plate and again to the poles.

Using monochromatic and polarized light at the highest magnifications available, the writer was unable to observe a physical connection between the nucleolus and the spireme, or to ascertain definitely the existence of nucleolar or other material within the latter. Neither was he able to find mitotic stages which revealed the behavior of the chromosomal "core" during the splitting of the chromosomes at the equatorial plate and during reconstruction, although at the equatorial plate the chromosomes show distinctly their "tubular" structure.

The external diameters of the spiremes and chromosomes, after this fixation, are, taking measured averages, no greater than the external diameters of the spiremes and chromosomes of similarly situated cells, in the same phases, following other fixations. The outlines of the cells are smooth, the surfaces of the spiremes and chromosomes show no undue irregularity; in short, there is no evidence of an artifact greater than that resulting from the fixing of the cells by other methods.

While "tubulated" chromosomes have been described many times previously, they were almost invariably demonstrated by the cruder stains whose action is dependent upon mordanting, length of time of staining and destaining, and various other purely physical factors. Their description after a method which stains chromatin with chemical selectivity may aid in an interpretation of their true structure.

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[1] R. Feulgen, "Die Nuclealfärbung." Handbuch der biologischen Arbeitsmethoden, 213: 1055–1073. 1926.

[2] C. Zirkle, "Nucleolus in Root Tip Mitosis in Zea Mays." Botanical Gazette, 86: 402–418. 1928.

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